

APPLICATION FOR UNITED STATES LETTERS PATENT

for

MULTIPLE LED FOCUSED LIGHTING DEVICE

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MULTIPLE LED FOCUSED LIGHTING DEVICE

2 **FIELD OF INVENTION**

 The present invention relates generally to the field of light emitting diodes. More
4 specifically, the present invention is directed to a lighting device that uses the light from
multiple LEDs focused on an optic fiber in order to create high output lighting.

6 **BACKGROUND OF INVENTION**

 Light emitting diodes (LEDs) are well known solid state light sources. LEDs
8 have many advantages over traditional lighting sources such as incandescent bulbs as
they are cheaper to produce, more robust, and require less power. LEDs are especially
10 desirable as they emit light with high power efficiency over specific colors in the
spectrum. However, LEDs are not a focused light source and suffer from relatively low
12 light output. The lack of focused light and low light output prevents application of LEDs
to uses where high light intensity is desired. Further LEDs cannot be fabricated in
14 different shapes for decorative purposes. Finally, the light output of LEDs cannot be
intensified without an optical device to focus the light.

16 There are many commercial applications requiring high light output. For
example, there is a great demand for outdoor and indoor decorative or architectural
18 lighting. Neon lighting is presently used for such applications. Neon or fluorescent
lighting uses a glass tube which is filled with neon gas. Such devices may be used for
20 lighting but also for advertising and signs as the tubes may be fabricated into different

shapes. Such tubes may have different colors or generate simple white light. The light
2 intensity of a neon tube depends on the color generated.

However neon lighting suffers from a number of problems. Neon lights require a
4 relatively large amount of electricity to offer resulting in greater costs for heavy use such
as outdoor signs. Also, neon lights require periodic replacement and maintenance
6 because such lights experience a significant drop off in output after continual use.
Further, the maximum length of a neon tube is around seven feet which necessitates more
8 units for large scale uses. All of these factors may create cost issues. Also, neon lights
require a high voltage transformer which may create safety issues. Finally, neon lights do
10 not allow for easy change of the light color output.

Another solution for outdoor applications is high intensity discharge ("HID")
12 lamps. HID lighting technology replaces the filament of the light bulb with a capsule of
gas. The light is emitted from an arc discharge between two closely spaced electrodes
14 hermetically sealed inside a small quartz glass tubular envelope capsule. To operate, they
require ballasts, which supply proper voltage and control current. The amount of light
16 produced is greater than a standard halogen bulb, while consuming less power, and more
closely approximating the color temperature of natural daylight. Unfortunately, HID
18 lighting has a short relative lifetime, requiring periodic replacement. Further, the HID
lighting requires greater maintenance and repair.

20 Thus, there is a need for an LED based device which provides sufficient light
intensity for high lighting applications. There is a further need for an LED based device

which allows light output to be focused and directed. There is also a need for an LED
2 based device which allows high light output from the end of an optic fiber. There is yet
another need form an LED based device which allows bright side light effect. There is
4 also a need for a low power, high reliability, lighting device suitable for commercial
applications.

SUMMARY OF THE INVENTION

8 These needs and others may be met by the present invention, one example of
which is a high output lighting device. The device has a support bracket having one end
10 with a vertically extended arm and an opposing end with a lighting mounting bracket. An
optic fiber having a receiving end and an emitting end supported by the vertically
12 extended arm is provided. Multiple light emitting diodes are supported by the lighting
mounting bracket and the multiple light emitting diodes are spaced at a fixed distance
14 from the receiving end of the optic fiber and are angled to focus light output on the optic
fiber.

16 Another example of the invention is a high output light emitting diode based
lighting device. The lighting device has a support bracket having a flat bottom surface
18 and two opposite first and second ends. A vertical support arm is attached to the first end
of the support bracket. An optic fiber is attached to the vertical support arm, the optic
20 fiber has a core material and a cladding material with a flat receiving end fixed in relation
to the support bracket. A mounting arm is attached to the second end of the support

2 bracket, the mounting arm includes multiple collars facing the receiving end of the optic
fiber. A light emitting diode reflector assembly is attached to each of the multiple
collars. The light emitting diode reflector assembly has a conical body having an open
4 end mated with the collar, and an opposite closed end holding a light emitting diode.

It is to be understood that both the foregoing general description and the
6 following detailed description are not limiting but are intended to provide further
explanation of the invention claimed. The accompanying drawings, which are
8 incorporated in and constitute part of this specification, are included to illustrate and
provide a further understanding of the method and system of the invention. Together
10 with the description, the drawings serve to explain the principles of the invention.

12 **BRIEF DESCRIPTION OF DRAWINGS**

These and further aspects and advantages of the invention will be discussed more
14 in detail hereinafter with reference to the disclosure of preferred embodiments, and in
particular with reference to the appended Figures wherein:

16 FIG. 1 is a perspective view of a lighting device with multiple LEDs according to
one example of the present invention;

18 FIG. 2 is a side view of the support bracket holding the LEDs of the lighting
device shown in FIG. 1;

20 FIG. 3 is front view of the support bracket holding the LEDs of the lighting
device shown in FIG. 1;

FIG. 4 is an exploded view of the lighting device with multiple LEDs shown in
2 FIG. 1;

FIG. 5 is a cutaway view of the lighting device in FIG. 1 showing the path of the
4 light rays emitted by the LEDs for a side light effect;

FIG. 6 is a view of the lighting device in FIG. 1 showing the path of light rays
6 emitted by the optic fiber for an end light effect;

FIG. 7 is a circuit diagram of the lighting device in FIG. 1;

8 FIG. 8 is an alternate circuit diagram for the lighting device in FIG. 1 used for
different color output; and

10 FIG. 9 is a perspective view of an alternate embodiment of the present invention
using a different number of LEDs.

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DESCRIPTION OF THE PREFERRED EMBODIMENT

14 While the present invention is capable of embodiment in various forms, there is
shown in the drawings and will hereinafter be described a presently preferred
16 embodiment with the understanding that the present disclosure is to be considered as an
exemplification of the invention, and is not intended to limit the invention to the specific
18 embodiment illustrated.

FIGs. 1-4 show a lighting device 10 that is one example of the present invention.
20 FIG. 1 is a perspective view, FIG. 2 is a side view, FIG. 3 is a front view and FIG. 4 is an

exploded view of the lighting device 10 which is a high output lighting device useable for
2 indoor or outdoor architectural lighting.

The lighting device 10 has a support bracket 12 having a vertical arm 14 which
4 supports an optic fiber 16. The optic fiber 16 is shown in FIGs. 1-4 as a linear rod shape.
However, the optic fiber 16 may be formed or twisted in any variety of non-linear shapes.
6 For example, the optic fiber 16 may be bent into the shape of a letter for a commercial
application. In this example, the optic fiber 16 is manufactured by 3M, although other
8 optic fibers which allow for side or end light effects may be used. The optic fiber 16 is
preferably plastic to be flexible and resistant to fatigue, elongation and vibration. The
10 optic fiber 16 has a core material which is preferably polymethacrylate and a cladding
material which has a lower refractive index than the core material. When light enters the
12 optic fiber 16, it is transported down the length of the fiber by total internal reflection
between the core and cladding layers.

14 The support bracket 12 also includes an LED lighting support 18. The LED
lighting support 18 suspends LED reflector assemblies 20, 22, 24, 26, 28, 30, 32, 34, 36
16 in a symmetrical pattern. The LED reflector assemblies 20-36 are essentially identical
components. Each LED reflector assembly 20-36 is held in a fixed position by the LED
18 lighting support 18 to focus light output on the optic fiber 16.

The LED support 18 includes a locking plate 38 which has a series of locking
20 collars 40 each having a circular aperture 41. The LED reflector assemblies 20-36 are
inserted in the locking collars 40 through the circular apertures 41. Each collar 40 is set

at an angle on the plate 38 and a certain distance relative to the optic fiber 16 in order to
2 focus light on the optic fiber 16.

The LED reflector assembly 20 has a conical body 42 having an open front end
4 44 and a closed back end 46 holding a light emitting diode 48. It is to be understood that
the other LED reflector assemblies 22-36 are identical to the LED reflector assembly 20
6 and operate in the same manner. The open front end 44 of the conical body 42 has a pair
of mounting tabs 50 and 52. The mounting tabs 50 and 52 have mounting holes 54 and
8 56 which are used in conjunction with fastening devices such as a rivet or a screw to fix
the conical body 42 in place relative to the collar 40 of the locking plate 38.

10 The conical body 42 has a reflective interior surface 58 which is preferably coated
with evaporated aluminum. The reflective interior surface 58 of the conical body 42
12 focuses the light emitted from the light emitting diode (LED) 48. The LED 48 is any
semi-conductor, solid state light source. In the preferred embodiment, the LED 48 is a
14 Luxeon light emitting diode since it offers a lower thermal resistance. The LED 48 is
mounted on the closed end 46 of the conical reflector 42 and may be coupled to a power
16 source (not shown) via two electrical pins 60 and 62. The closed end 46 of the conical
reflector 42 is connected to a heat sink 70 which serves to dissipate the heat generated by
18 the LED 48. The heat sink 70 allows for the use of higher power and thus higher light
intensity output LEDs.

20 The heat sink 70 includes a flat plate 72 which has a mounting collar 74 which is
attached to the back end 46 of the conical reflector 42. The flat plate 72 has a back

surface 76 which has a series of protruding, vertical vanes 78 to assist in dissipation of heat. The heat sink 70 is typically made from a highly thermally conductive material such as die cast aluminum alloy to conduct and dissipate heat generated from the LED 48. Of course other thermally conductive materials such as copper or thermally conductive plastic may be used to fabricate the heat sink 70. It is to be understood that rather than having separate heat sinks such as heat sink 70 for each of the LED reflector assemblies 20-36, a single heat sink could be thermally coupled to all of the LEDs 48 in the reflector assemblies 20-36.

The components of the LED reflector assembly 20 may be better viewed with reference to LED reflector assembly 28 shown in exploded view in FIG. 4. The LED reflector 28 has identical element numbers as those assigned to LED reflector assembly 20 shown in FIGs. 1-3.

The LED support 18 has a tongue 80 which has a series of mounting holes 82. The tongue 80 is joined to a triangular vertical arm 84 extending from the support bracket 12 via rivets or screws that are installed in the mounting holes 82. The support bracket 12 also has a series of four feet 86, 88, 90 and 92 which extend outward and provide a flat surface to mount the support bracket 12 on a flat surface. Each of the feet 86-92 has a hole 94, 96, 98 and 100 respectively. The feet 86-92 may be bolted to a surface for mounting the lighting device 10 via the holes 94-100.

The vertical arm 14 holds the optic fiber 16 at a fixed distance from the LED support 18. The vertical arm 14 has a base 102 which is fixed to the surface plane of the

support bracket 12. The vertical arm 14 also has a mounting cradle 104 opposite the base
2 102. The mounting cradle 104 has a channel 106 having a semi-circular shape to
accommodate the optic fiber 16. A locking bar 108 has an opposite semi-circular
4 channel 110 to hold the optic fiber 16 in place. The locking bar 108 has two slots 112
and 114 which accommodate screws to hold the locking bar 108 on the mounting cradle
6 104.

The optic fiber 16 has a body 126 and a receiving end 128 which receives the
8 light from the LEDs mounted in the LED reflectors 20-36 and an emitting end 130. The
optic fiber 16 allows end light emission from the emitting end 130 or side light effect
10 from the perimeter of the body 126.

As shown in FIG. 5, light from the LEDs 48 in the LED reflector assemblies 20-
12 36 may be directed toward the receiving end 108 and channeled through the body 126 of
the optic fiber 16 for a bright side light effect. The LED reflector assemblies 20-36 are
14 angled in order to maximize the amount of light output from the LEDs 48 transmitted to
the optic fiber 16. In addition, the conical body 42 is shaped such that the reflective
16 surface 58 reflects incident light from the LEDs 48 to the optic fiber 16. The basic shape
of the conical body 42 is an ellipse according to the equation of $x^2/A + y^2/B = 1$. The
18 ellipse shape has two foci which enables light collection. The reflector 20 may also be a
compound elliptical concentrator that also has two foci.

20 The combined light from the nine LEDs 48 allows sufficient intensity light output
from the optic fiber 16 for different applications. In this case, the cladding material of the

optic fiber 16 is translucent. When the light from the LEDs 48 is focused on receiving
2 end 128, it is scattered at the core/cladding interface and leaves the body 126 along the
perimeter of the optic fiber 16. The light emission appears visually uniform along the
4 length of the optic fiber 16. Since the light is directed by the optic fiber 16, any shape
may be formed by the body 126 and corresponding light will be emitted throughout the
6 body 126.

As shown in FIG. 6, light from the LEDs 48 may also be directed from the
8 emitting end 130 of the optic fiber 16. In this instance, a black jacket covers the cladding
of the fiber and channels the light out of the emitting end 130. This embodiment may be
10 used for remote light applications like microscope lighting, endoscope lighting and
machine vision. As described above, the lighting device 10 allows all of light emitted by
12 the LEDs 48 to be focused on the optic fiber 16 for a combined high light output.

FIG. 7 is a circuit diagram of the electrical control for the LEDs 48 in the lighting
14 device 10. The circuit diagram includes a power source 140 which is a typical AC power
source. The power source 140 is coupled to a power supply 142 which transforms the
16 AC power from the power source 140 to a DC voltage. The power supply 142 supplies a
sufficient voltage supply for the LEDs 48 which in this example are the same color.

18 Different colors may be used by changing the color of the exterior of the optic
fiber 16. Different colors may also be generated by providing different color LEDs.
20 Additionally, other colors may be generated by having several different color LEDs and
using the combination of the different colors to generate another color. For example, the

LEDs in the lighting device 10 may be wired according to the circuit shown in FIG. 8.

2 FIG. 8 shows a power supply 150 which is coupled to a power source 152. The power
source 152 is coupled to a red set of LEDs 154, a green set of LEDs 156 and a blue set of
4 LEDs 158. The combination of the sets of LEDs 154, 156 and 158 may be used to
generate different colors by varying the current to the LED outputs.

6 FIG. 9 shows a perspective view of a second alternate embodiment of a lighting
device 200. The lighting device 200 has a support bracket 202 which has one end
8 holding an optic support arm 204 which holds an optic fiber 206. The opposite end of the
mounting bracket 202 includes an LED support arm 208. The LED support arm 208
10 holds a series of fifteen LED reflector assemblies 210 which all contain light emitting
diodes 212. The LED assemblies 210 each have a conical reflecting surface 214 which
12 focus light emitted by the LED 212 to the focal point of the optic fiber 206. The LED
212 is also coupled to a heat sink 216 to dissipate heat generated by the LED 212.

14 Similar to the previous example, light from the LEDs 212 are all focused by the
angle of the respective LED reflectors 210 and the reflecting surfaces 214 to the optic
16 fiber 206. The light of all of the fifteen LEDs 212 are thus captured by the optic fiber
206 and emitted over the length of the optic fiber.

18 The lighting device 200 has fifteen LEDs which generate greater amounts of light
than the nine LEDs in the lighting device described in FIG. 1. It is to be understood that
20 different numbers of LEDs may be used in order to vary the intensity of the output.

2 Additionally, light intensity may be varied by selectively powering certain LEDs in the
array.

4 It will be apparent to those skilled in the art that various modifications and
variations can be made in the method and system of the present invention without
departing from the spirit or scope of the invention. Thus, the present invention is not
6 limited by the foregoing descriptions but is intended to cover all modifications and
variations that come within the scope of the spirit of the invention and the claims that
8 follow.